2. CYLINDER HEAD, VALVES, AND RELATED PARTS

Cylinder Head

The cylinder head can be removed from the engine for service with the engine installed in the tractor. When removing the Ford 7500 cylinder head, first remove the turbocharger. For instructions, see Chapter 2, Part 1.

A. Removal

1. Remove the vertical muffler, if so equipped, and disconnect the main wiring harness from the hood panel assembly. Remove the hood panel assembly.
2. Remove the battery (Ford 6500). Remove the air cleaner assembly and related components. Remove the battery tray support bolts from the head (Ford 6500) and remove the radiator shell support. Disconnect the exhaust pipe from the exhaust manifold on units that are equipped with horizontal exhaust systems. Drain the radiator and cylinder block.

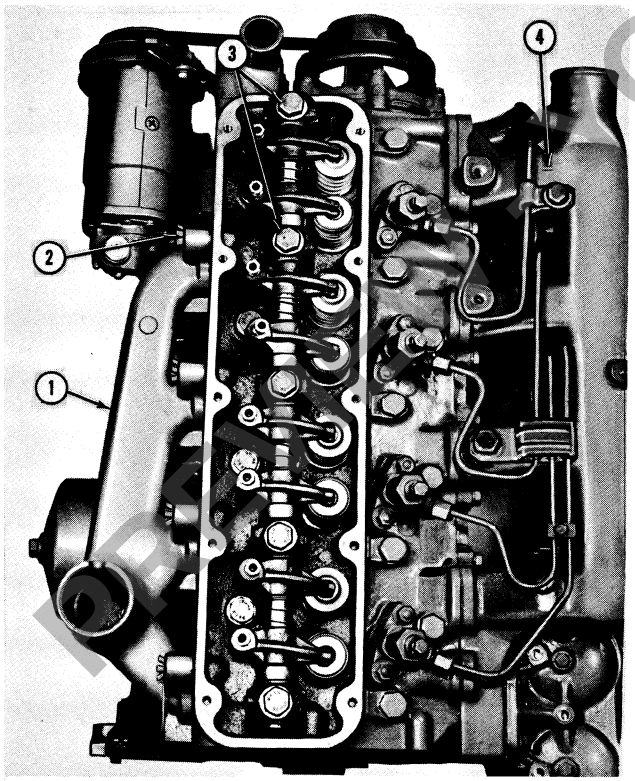


Figure 2
Engine with Rocker Arm Cover Removed

1. Exhaust Manifold
2. Lock Tabs
3. Cylinder Head Bolts
4. Intake Manifold

3. Bend the lock tabs back, Figure 2, and remove the bolts that secure the exhaust manifold to the cylinder head.
4. Remove the exhaust manifold and metal gasket, Figure 2.
5. Remove the injector lines from the injection pump and from the injectors. Cap the exposed openings in the pump and in the injectors, and all tube ends to prevent the entry of dirt.
6. Disconnect cold start equipment where equipped.
7. Disconnect the air inlet hose at the clamp at the intake manifold.
8. Shut off the fuel at the tank (Ford 6500). Remove the fuel filter from the manifold by disconncting the fuel lines and removing two bolts and flat washers and cap the openings.
9. Remove the bolts and lock washers that retain the intake manifold, Figure 2, to the cylinder head and remove the manifold and gasket.
10. Disconnect the ventilation tube from the rocker cover. Remove the bolts that attach the rocker arm cover to the cylinder head and remove the rocker arm cover and gasket.
11. Disconnect the injector leak-off line. Remove the two nuts from the studs that retain each injector, Figure 3, and remove each injector from its bore in the cylinder head. Be sure the area surrounding the injectors is clean. If the injectors can not be readily pulled by hand, it may be necessary to pry the injectors out.
12. Visually check the push rods for straightness before they are removed by rotating them with the valve closed. Loosen the bolts that retain the rocker shaft to the cylinder head, Figure 2, evenly and alternately until all tension has been relieved, and lift the rocker shaft assembly from the cylinder head.

    NOTE: The rocker shaft retaining bolts should be left in place in the rocker shaft supports during removal. The bolts hold the rocker shaft assembly together; therefore, only remove the bolts when it is necessary to disassemble the rocker shaft.

13. Remove the valve push rods from their holes in the cylinder head and arrange them in a rack in the order in which they were removed.
14. Remove the remaining cylinder head attaching bolts and carefully lift the cylinder head from the block.

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Torque Specifications (Lubricated Threads)	Thread Size	Pounds Feet	Meter Kilograms

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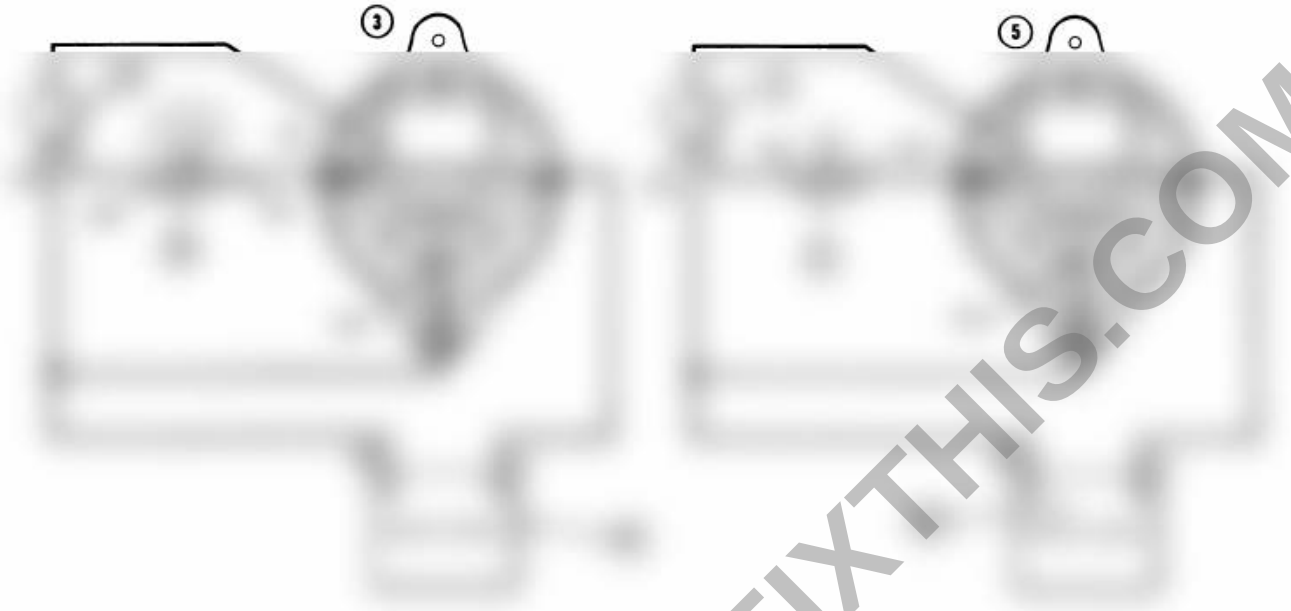
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C. Flywheel Ring Gear Repair

1. The mating surfaces of the flywheel and the ring gear must be cleaned thoroughly and any manufacturing "flash" on the gear teeth should be removed.
2. Use two temperature indicating crayons: One indicating 400° F. (204° C.), one indicating 450° F. (212° C.). (These crayons are designed to melt at a specified temperature.)
3. Mark the inner half of the gear face at six equally spaced places with the 400° F. (204° C) crayon. Mark the face just below the root of the tooth at each of these six places with the 450° F. (212° C) crayon.
4. Heat the gear evenly with an oxy-acetylene torch having a tip size not larger than No. 2 and a rich acetylene adjustment. Direct the flame against the inside of the gear so the heat will travel outwards toward the teeth. Avoid directing the flame against either face of the gear. Stop applying heat when the 400° F. (204° C.) crayon mark melts and before the 450° F. (212° C.) crayon begins to melt. Quickly spot check the 400° F. (204° C.) crayon to be sure the gear and not the flame has melted the crayon marks.
5. Quickly place the hot gear on the flywheel with the flat gear face against the shoulder on the flywheel. Be sure the gear face is flush with the shoulder on the flywheel, then quench the gear with water to cool it rapidly.

D. Flywheel Installation

1. Clean the crankshaft rear flange and the mating surface of the flywheel.
2. Determine the correct relationship of the bolt holes in the flywheel and crankshaft and place the flywheel in position on the crankshaft. Install the grease baffle and six capscrews and tighten to the specified torque. Recheck flywheel runout.
3. Reassemble the tractor as outlined in Part 8, "TRACTOR COMPONENT REMOVAL."

Crankshaft

A. Removal

1. Remove the engine from the tractor as outlined in Part 8, "TRACTOR COMPONENT REMOVAL."
2. Remove the flywheel and the engine rear cover plate.
3. Remove the crankshaft pulley and engine front cover, as outlined on page 12.

NOTE: If the crankshaft is to be removed with the cylinder head in position, first realign all timing marks. This is necessary so that the interference between the valves and pistons does not occur during reassembly.

4. Remove the oil pan sump and oil pump, as outlined on page 17, "OIL PAN SUMP REMOVAL," and page 18, "OIL PUMP REMOVAL."
5. Remove the balancer as previously outlined in this section.
6. Remove the connecting rod bearing caps and liners. Remove the main bearing caps and liners.
7. Make sure all of the bearing caps and liners are identified so they can be installed in their original position.
8. Carefully lift the crankshaft out of the cylinder block so the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible damage to the finished surfaces.

B. Inspection

NOTE: Current production engines may have a crankshaft with main bearings and/or crankpin bearing journals ground 0.010 in. (0.254 mm) undersized. These crankshafts can be identified from the letters "010 MUS" and/or "010 PUS" stamped on one of the counterbalance weights of the crankshaft.

1. Clean the crankshaft in a tank of solvent. Clean all drilled passages with a rifle brush, then blow out the passages with compressed air.
2. Place the crankshaft on V-blocks to check the runout at the intermediate main bearing journals with a dial indicator. If the crankshaft appears damaged or misaligned, or if the runout exceeds the specified limits, page 63, install a new crankshaft.
3. Inspect the main and connecting rod journals for cracks, scratches, grooves, or scores. Dress minor imperfections with an oil stone. Refinish severely marked journals.
4. Measure the diameter of each journal in at least four places to determine out-of-round, taper or wear, Figure 60. If the journals exceed the specified wear limits, page 63, they should be refinished to size for the next undersize bearings, Page 65.

C. Repair

1. If the crankshaft gear teeth are excessively worn, or if any teeth are chipped, install a new crankshaft gear. Remove the gear as outlined on page 15, "CRANKSHAFT GEAR REMOVAL."

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Part 1

ENGINES

Chapter 4

TROUBLE SHOOTING, SPECIFICATIONS, AND SPECIAL TOOLS

Section		Page
1.	Trouble Shooting	59
2.	Specifications	61
3.	Special Tools	69

1. TROUBLE SHOOTING

Trouble	Possible Causes
Engine Does Not Develop Full Power	1. Clogged air cleaner. 2. Fuel line obstructed. 3. Faulty injectors. 4. Low cylinder compression. 5. Improper valve lash adjustment. 6. Burned, worn, or sticking valves 7. Blown head gasket. 8. Incorrect fuel delivery.
Engine Knocks	1. Diluted or thin oil. 2. Insufficient oil supply. 3. Low oil pressure. 4. Excessive crankshaft end play. 5. Excessive flywheel runout. 6. Excessive connecting rod or main bearing clearance. 7. Bent or twisted connecting rods. 8. Crankshaft journals out-of-round. 9. Excessive piston-to-cylinder bore clearance. 10. Excessive piston ring side clearance. 11. Broken rings. 12. Excessive piston pin clearance. 13. Piston pin retainer loose or missing. 14. Excessive camshaft end play. 15. Imperfections on timing gear teeth. 16. Excessive timing gear backlash.

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2. SPECIFICATIONS

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Part 1

ENGINES

Chapter 1

ENGINES AND LUBRICATING SYSTEM

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4.	Oil Pan Sump and Oil Pump	17
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6.	Balancer, Main Bearings, Flywheel, and Crankshaft	30
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Chapter 2

TURBOCHARGER - FORD 7500

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Chapter 3

COOLING SYSTEM

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Chapter 4

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TURBOCHARGER DIAGNOSIS GUIDE

Problem	Possible Cause	Correction
DAMAGED COMPRESSOR BLADES	Foreign object	Determine source and correct.
DAMAGED TURBINE BLADES	Foreign object	Determine source and correct.
DAMAGED TURBINE AND COMPRESSOR BLADES	Turbine shaft or bearing worn (possibly due to cold start)	Install necessary new parts.
CARBONIZED CRUST ON BEARING	Excessive heat (due to hot shut-down)	Install necessary new parts.
BEARING DISCOLORED TO BLUE (OR BLACK)	Excessive exhaust temperatures	Determine cause and correct.
BEARING WEAR ON ENDS OF OUTER SURFACES	Damage due to dirty oil	Install necessary new parts, change oil and filter.
BEARING BRONZE WIPED ONTO SHAFT	Due to cold start (oil lag)	Possibly require new bearing and shaft.
END OF BEARING WORN	Excessive end play	Install new wear parts.
DIRT BUILD-UP COMPRESSOR WHEEL OR COVER	Air leak between air cleaner and compressor operating without air cleaner	Locate and repair leak. Install clean air filter
EXCESSIVE WEAR ON BACK OF TURBINE WHEEL	Oil lag or starvation	Determine cause and correct. Install necessary new parts.
BURNT OR WORN OIL SEAL RINGS	Oil lag or starvation	Determine cause and correct. Install necessary new parts.
HEAT DISCOLORATION OR EXCESSIVE WEAR OF THRUST BEARINGS AND WASHER	Oil starvation	Determine cause and correct. Install necessary new parts.

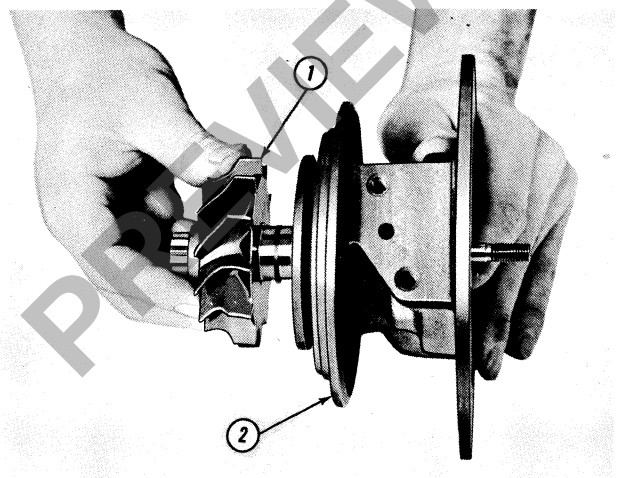


Figure 77
Turbine Wheel and Shaft Installation

1. Turbine Shaft and Wheel Assembly
2. Bearing Housing

4. Lubricate the thrust bearing thoroughly and install it, bronze face up, over the shaft, aligning the holes in the bearing with the two dowel pins in the bearing housing. See Figure 78.
5. Install the thrust ring over the shaft and against the thrust bearing.
6. Place the oil deflector, with the lip down, over the shaft, aligning the holes in the deflector with the two dowel pins in the bearing housing.

   NOTE: The oil deflector will go on the pins only one way. Make sure the deflector is correctly positioned on the dowel pins.

7. Install the sealing ring in the groove of the flinger sleeve and lubricate thoroughly. Press the flinger sleeve into the compressor insert so that the flat side of the flinger sleeve is flush with the flat side of the compressor insert.
8. Lightly lubricate the new O-Ring and place it in the groove in the compressor insert.

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Chapter 4

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FIELD COIL INSPECTION AND REPAIR:

1. Check the field coils by performing the field coil ground circuit test as covered on page 44.
2. Unsolder the field coil leads from the field terminal.
3. Unsolder the eyelet cable from the field coil connection.
4. Remove the pole shoe screws following the method illustrated in Figure 85. The highly-torqued screws require the use of a press to keep the tool engaged.

NOTE: A tool can be fabricated by welding the end of a Phillips head screwdriver to a nut if Tool No. CP 9504 is not available.

5. Remove the insulation band.
6. Remove the pole shoes and field coils from the starting motor frame.
7. Position the new field coils over the pole shoes and place the coils in the starting motor frame.
8. Place the insulation band in position.
9. Install the pole shoes retaining screws, Figure 85. While tightening the screws, tap the starting motor frame with a soft-faced hammer to align and set the pole shoes. Once installed, stake the screws to prevent them from loosening.
10. Resolder the field coil leads to the starting motor field terminal using resin core solder.
11. Resolder the eyelet cable connections.
12. Check the field coils for grounding as outlined on page 44.
13. Reassemble the starting motor as outlined on page 48.

DRIVE ASSEMBLY INSPECTION:

Check the operation of the roller clutch. The pinion should rotate clockwise only. See Figure 86. If the pinion is stuck, rotates in both directions, or if the pinion teeth are damaged, install a new drive assembly. If damaged pinion teeth are evident, check the flywheel ring gear teeth as covered in Part 1, "ENGINES."

E. Assembly

Refer to Figure 74 to identify the components.

1. Secure the starting motor frame in a vise equipped with soft jaws. Use an air hose to remove dirt and abrasives from the frame.
2. Install the armature shim, intermediate plate, drive assembly, stop collar (flat side toward the armature), and a new collar retainer. Force the collar retainer over the stop collar to secure the components.



Figure 85
Pole Shoe Screw Removal and Installation

1. Pole Shoe 2. Fabricated Tool or Tool No. CP9504

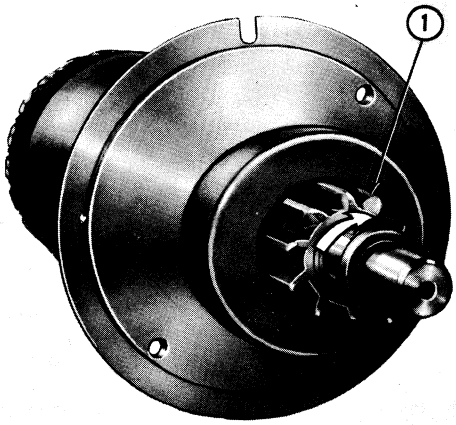


Figure 86
Pinion Gear Rotation

1. Pinion

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Part 5

REAR AXLE AND BRAKES

Chapter 1

REAR AXLE AND BRAKES

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Chapter 2

SPECIFICATIONS AND SPECIAL TOOLS

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5. Inspect the end assemblies for damage or worn threads. Replace as required.

C. Assembly

1. Install the piston inside ring (14) and the piston outside ring (13). Install the piston (12) on the piston rod (11) and secure with the hex lock nut (16). Tighten the nut to a torque of 30-35 lbs. ft. (4.15-4.84 kgm).
2. Use a new seal kit and, if necessary, a new cylinder gland. Install items 1-10 on the piston rod in the order shown.
3. Insert the assembled parts into the cylinder assembly (26).
4. Depress the cylinder gland (8) and install the retaining ring (1) in its groove.
5. Place the cylinder end plate (23) against the gland (8) and secure the plate with the three screws (19) and lock washers. Tighten securely.
6. Install the front (20) and rear (27) clamps and end assemblies (18) and (31). Secure with bolts, lock washers and nuts. Tighten securely.

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Oil entering the control valve exerts equal pressure in the high pressure passage (D) and the open center passage (A), (B), (C). When the spool is positioned to raise the boom, as shown in Figure 13, flow is partially restricted through the open center. The pumped oil, tending to follow the path of least resistance, diverts to the high pressure passage where it unseats the check valve (K) in the lift section, and flows into passage (E), around the spool into port (F) and on to the rod end of the lift cylinder. As a result, oil is forced from the piston end of the lift cylinder into port (G) of the control valve where it flows around the spool and into the return oil passage (J). The return oil flows through passage (J) to the outlet end cover and out through the outlet port to the reservoir (sump).

Lift Spool - Lowering Position

The oil flow is basically the same for lowering the boom as in raising the boom in that the pumped oil is diverted to (D) in the same manner. In this case, however, the spool has been moved to the right, Figure 15, thus, when the high pressure oil forces the check valve open and flows into passage (E), it flows around the spool and out through port (F) to the piston end of the lift cylinder. Oil forced from the rod end of the lift cylinder enters the lift section of the control valve through port (G), flows around the spool and into the low pressure return passage (H) and on to sump.

Regenerative Valve

A regenerative or anti-cavitation valve is located in the lift section and functions during a "fast drop" condition, such as rapidly lowering the boom when the bucket is full and oil is forced out of the rod end of the cylinder faster than the pump can supply oil to the piston end. A void will be formed in the piston end of the cylinder if additional oil

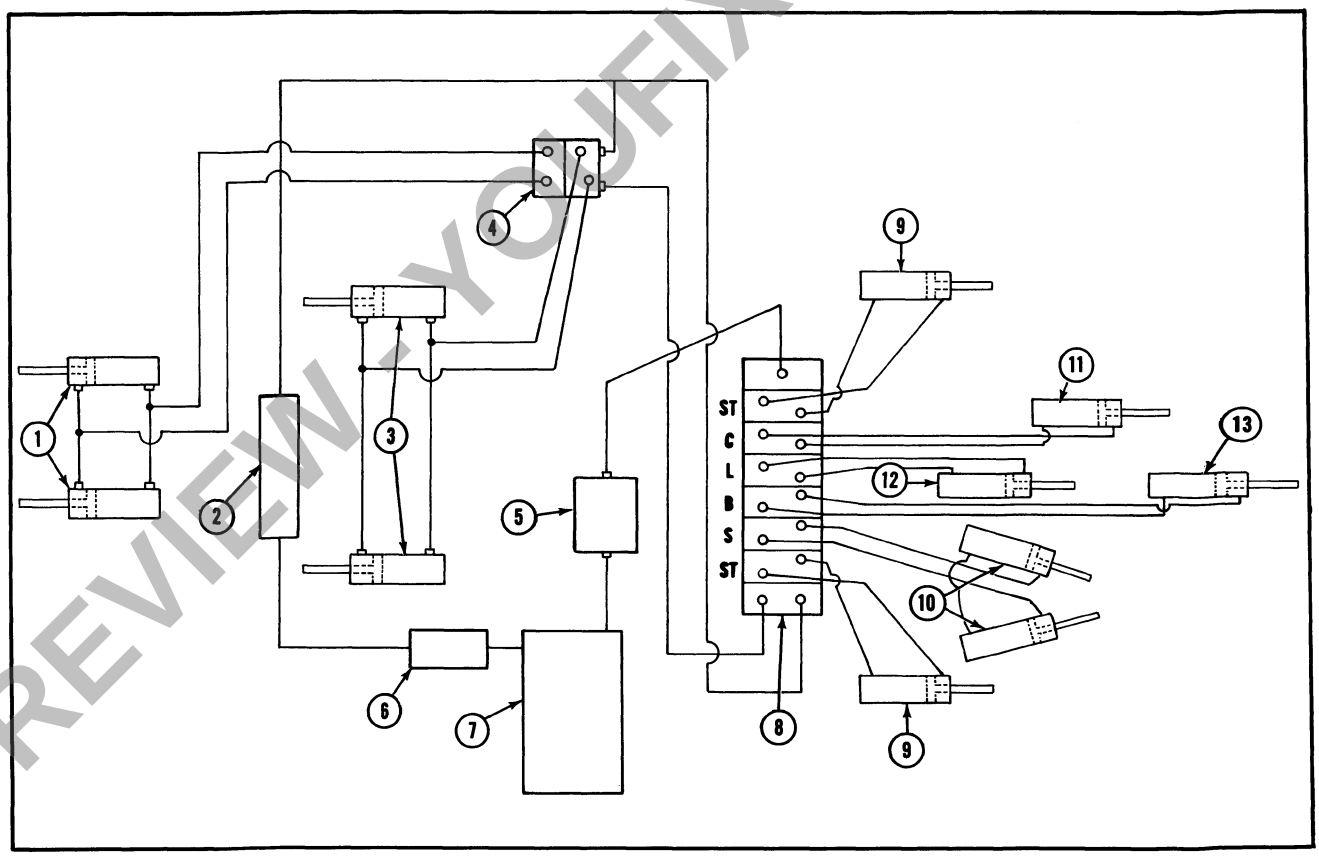


Figure 10
Schematic Hydraulic System

1. Loader Bucket Cylinders
2. Oil Cooler
3. Loader Lift Cylinders
4. Loader Control Valve
5. Hydraulic Pump
6. Filter
7. Reservoir
8. Backhoe Control Valve
9. Stabilizer Cylinders
10. Backhoe Swing Cylinders
11. Backhoe Crowd Cylinder
12. Backhoe Lift Cylinder
13. Backhoe Bucket Cylinder

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Loader Control Valve

The loader control valve is bolted to the right side of the loader-backhoe frame, Figure 94.

Before removing the valve, the bottom of the loader bucket should be resting on the floor and any pressure that may be in the system should be relieved by moving the loader control handle in all directions several times with the engine off. Also, it is suggested that the backhoe bucket and stabilizer pads be resting on the floor. This will prevent the possibility of losing oil at the loader control valve if the backhoe control handles are moved while the return tube is disconnected.

A. Removal

1. Remove the side panel to fain access to the valve, Figure 94.
2. Remove the cover plate, then disconnect the control lever from the valve spools by removing the cotter pins and clevis pins, Figure 95.
3. Disconnect the bucket cylinder tubes and lift cylinder tubes, Figure 94, from the valve and elbow. Cap the openings.

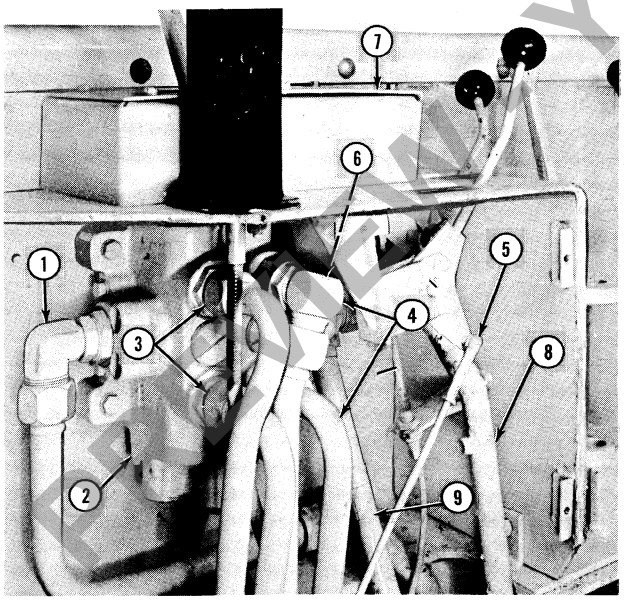


Figure 94
Loader Control Valve Installed

1. Power Beyond
2. Loader Control Valve
3. Bucket Tubing
4. Lift Tubing
5. Throttle Linkage
6. Valve Inlet
7. Cover Plate
8. Inlet Tube
9. Outlet Tube

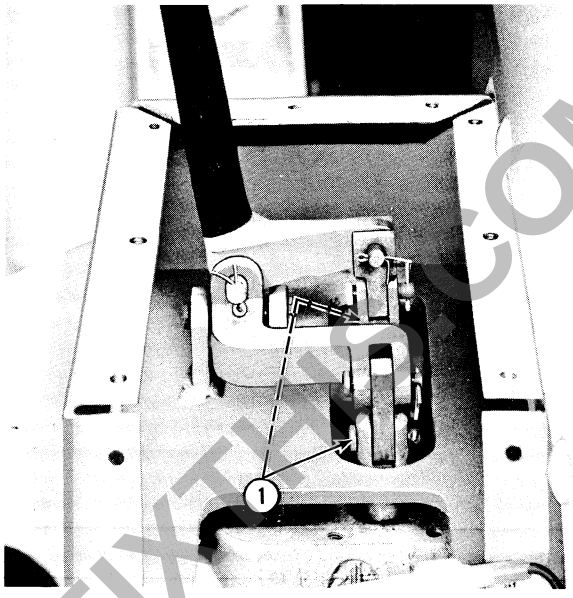


Figure 95
Loader Control Lever Linkage

1. Clevis Pins and Cotter Pins

4. Disconnect the throttle rod at the bell crank, then disconnect the inlet tube from the control valve.
5. Disconnect the outlet tube from the tee fitting and the power beyond tube. Cap the openings.
6. Remove the valve from the frame by removing the attaching bolts.
7. Remove the outlet tube, elbow, and restrictor from the valve.

B. Dissembly

Because the bucket and lift spools (9) and (10), Figure 96, are a select fit in the body sections (3) and (7), they cannot be serviced separately. If a spool or body requires replacement the corresponding body or spool must also be replaced. All parts of the system relief valve (16), Figure 96, can be serviced individually with the exception of the body (22), Figure 96.

To disassemble the loader control valve:

1. Separate the bodies (3) and (7), Figure 96, by removing the thru-bolts
2. Remove the O-Rings (8) from the lift body (7).
3. Remove the check valves (6) and (4), and the spring (5) from the bodies by removing the poppets (6), Figure 96.

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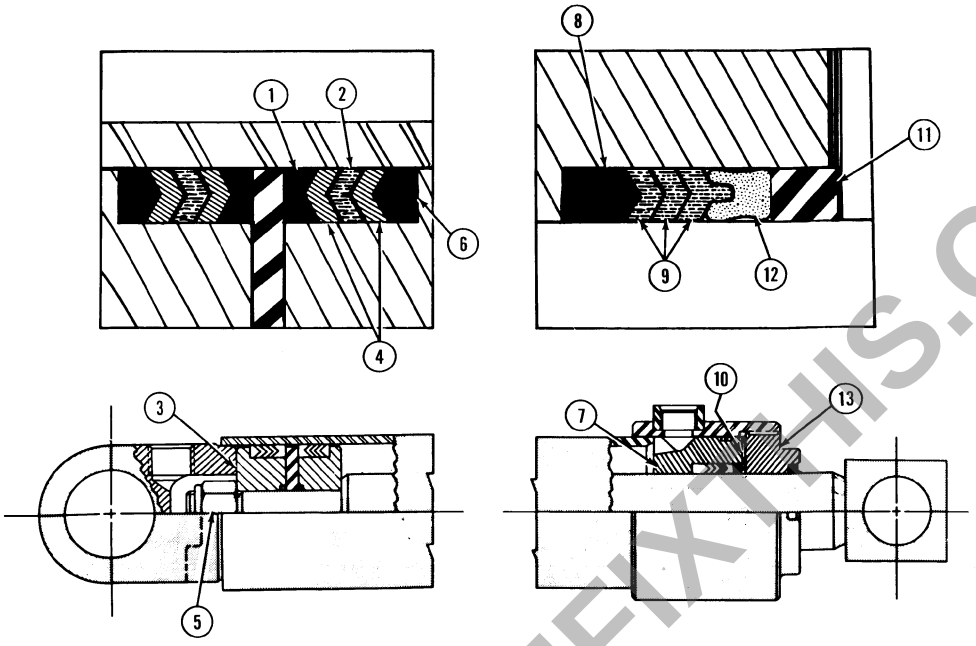


Figure 3
Loader Bucket and Lift Cylinder Components

1. Nylon Female Adapter
2. Fabric Vee Ring
3. Seal
4. Hard Nylon Vee Rings
5. Piston Nut
6. Nylon Male Adapter
7. Gland
8. Nylon Male Adapter
9. Fabric Vee Rings
10. Shims
11. Phenolic Bearing
12. Urethane "U" Seal
13. Gland Nut

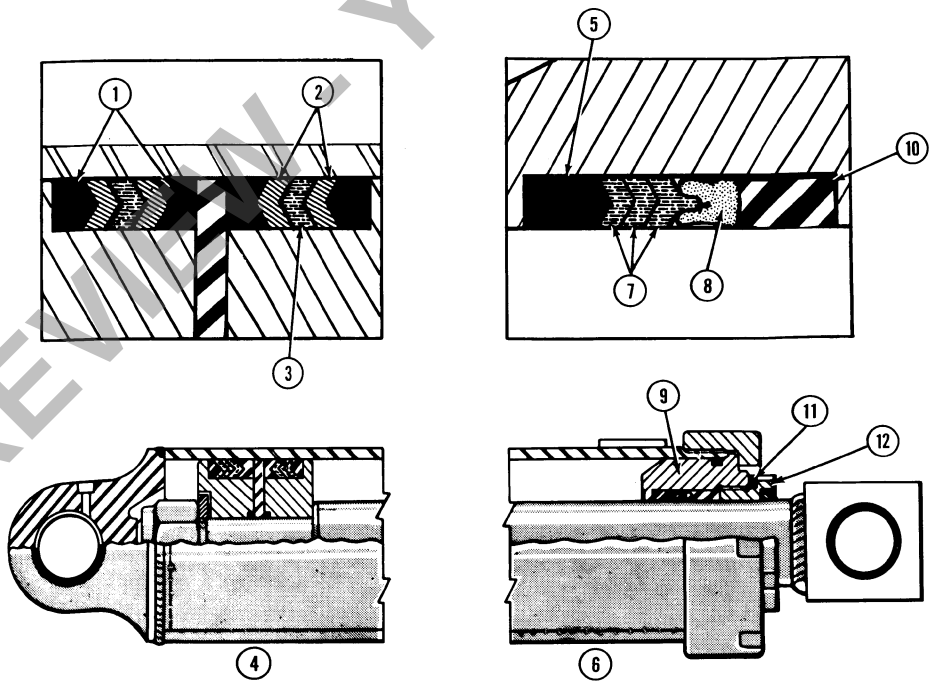


Figure 4
Backhoe Bucket, Crowd and Lift Cylinder Components

1. Nylon Male and Female Adapters
2. Hard Nylon Vee Rings
3. Fabric Vee Rings
4. Double Piston Packing
5. Nylon Male Adapter
6. Gland Packing
7. Fabric Vee Rings
8. Urethane "U" Seal
9. Gland
10. Phenolic Bearing
11. Shims
12. Packing Nut

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System Relief Valve and Circuit Relief Valves

The system relief valve and circuit relief valves are serviced as individual parts or as assemblies. The assembled units are pre-set for pressure; however, they should be tested upon installation. Inspect the parts and replace the components needed unless there is a general worn appearance throughout the valve.

Check to make sure that the piston, poppet, and sleeve poppet each move freely within the body and return to the normal extended position. With a small soft rod, depress the sleeve poppet fully in the body. When the rod is quickly removed, the sleeve poppet should snap back to the extended position. Repeat this procedure for the poppet and piston. If any of these fail to snap back to the extended position, disassemble the valve and:

1. Check all O-Rings and back-up rings for wear, damage, or swelling. Mating parts must move freely with the O-Rings and back-up rings installed.
2. Inspect the inside of the sleeve poppet for evidence of wear caused by the poppet O-Ring and back-up ring. A slight groove will cause the poppet to stick open when operating under pressure, yet the poppet may move freely when depressed by hand.
3. Inspect the ground seating surface of the piston for nicks or excessive wear. The piston should be free of nicks and abrasions.
4. Inspect the pilot poppet seat in the plug and the seats on the pilot poppet. These seats should show a complete seating surface.
5. Visually check the springs for "set" by comparing their lengths to new springs. Install new springs if necessary.

Check Valves

Check valve malfunctioning is usually the result of foreign material lodging between the seat and the poppet.

1. Examine the seat surface for dirt or metal particles. Check the seating surfaces for nicks or scratches.
2. Minor nicks and scratches can be removed by using a fine lapping compound. Care must be exercised to prevent lapping compound from entering and remaining in the valve body.

Regenerative Valve and Backpressure Valve

Malfunctioning of the regenerative valve usually is the result of foreign material lodging between the seat and poppet.

1. Examine the seat surface for dirt or metal particles. Check the seating surface for nicks or scratches.
2. Minor scratches and nicks can be removed using a fine lapping compound. Exercise care to prevent lapping compound from entering and remaining in the valve end cover.
3. Remove the O-Ring from the backpressure poppet and install a new O-Ring.
4. Install new O-Rings on the valve plugs.

Backpressure Relief and Unload Valves

1. Inspect the seats for nicks and scratches. Minor nicks and scratches can be removed with a fine lapping compound; however, care must be exercised to prevent lapping compound from entering and remaining in the end cover.
2. Check the springs for "set" by visually comparing them to new springs. Install new springs if necessary.

D. Assembly

System Relief Valve and Circuit Relief Valves

Refer to Figure 82 and proceed as follows:

1. Install a new O-Ring on the poppet (4), and install the poppet in the sleeve (3).
2. Install the piston (5) into the poppet (4).
3. Install a new O-Ring on the plug (7) and install the spring (6) into the plug. One end of the spring has a larger O.D. and should be placed into the plug.
4. Assemble the sleeve and plug and install the assembly into the cap (2).
5. Insert the pilot poppet (8) and spring (9) into the plug and install the adjusting screw (10), washer (11), jam nut (12) and acorn nut (13).

   NOTE: The system relief valve and circuit relief valves must be pressure checked and adjusted upon installation. Refer to Chapter 4, Section 2, for procedures.

6. Install a new O-Ring on the cap and secure the assembly into the valve body.

Spools

1. Lubricate the spool with a light coat of hydraulic oil and position the O-Ring, wiper, and retainer plate on the spring end of the spool.

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